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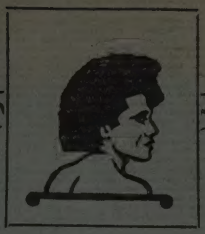

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So many requests are received from abroad for parts of the *Agricultural Journal* which were never published that the following list of all issues published and those which are not now available is given for reference. Attention is especially directed to Volume 7 which had only one part:—

Vol.			*Vol.*		
1.	3 numbers,	1928.	11.	4 numbers,	1940 (none).
2.	4 „	1929.	12.	4 „	1941 (none of Nos. 1 and 2).
3.	3 „	1930 (none).			
4.	4 „	1931.	13.	4 „	1942.
5.	2 „	1932 (none of No. 2).	14.	4 „	1943.
6.	2 „	1933.	15.	4 „	1944.
7.	1 „	1934.	16.	4 „	1945.
8.	4 „	1935–37 (none of No. 4).	17.	4 „	1946 (none of No. 1).
9.	4 „	1938 (none of Nos. 2, 3 and 4).	18.	4 „	1947 (none of No. 1).
			19.	4 „	1948 (Nos. 3 & 4 form a double issue.)
10.	4 „	1939 (none of Nos. 2 and 4).			

ISSUES OF THE AGRICULTURAL CIRCULAR.

NUMBERS and year of issue of the *Agricultural Circular* :—

Vol. 1,	1920,	12 numbers.	Vol. 4,	1923,	1 number.
2,	1921,	5 „	5,	1924–5,	2 numbers.
3,	1922,	4 „			

As number 4 of Vol. 3 was printed as " Volume 4 " and number 1 of Vol. 4 as " Volume 5 " it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

ANNUAL BULLETINS.

THE Annual Bulletin of Divisional Reports ran from 1931 to 1938 and was then discontinued.

OLD ISSUES OF AGRICULTURAL BULLETINS.

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—EDITOR.

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EDITORIAL . . .

MECHANICAL AIDS IN TROPICAL AGRICULTURE

Much interest has been aroused in studies which are being made of the suitability of various types of tractor and associated equipment for tropical agriculture.

Labour is an expensive item in tropical regions, particularly in the more humid places where weeds and grass call for constant attention and all farm operations from ploughing to harvesting must be conducted at the right time and without delay. The economy of labour is as important to the large estate holder as it is to the small producer. It is obvious that the more general use of mechanical aids will do much to improve the efficiency and economy of labour, aid in the diversification of tropical agriculture, and contribute to the drive for the improvement of the standard of living of tropical peoples.

It has already been shown that equipment such as bulldozers and related heavy types are of considerable service in clearing bush and jungle. Heavy tractors connected by chain and working on each side of the row can haul down old palms with the greatest of ease. Drainage is made easy by excavators and drainage implements. Secondary growth can be controlled by heavy disc implements and lighter growth by the power mower. All this work can be performed more efficiently in a fraction of the time and at much less operational cost than by normal hand and bullock labour.

Lighter equipment is available for the smaller planter and farmer. Certain types of tractor in this range, particularly crawlers, have demonstrated their usefulness in Fiji but there has been some reluctance to purchase wheel types despite their low initial cost and the heavy maintenance cost of track types working in hard and stony country. Problems of clearance may make it impossible to use the crawler in certain areas although wet conditions suggest the use of this type. Malayan experience has shown that certain tractors with iron wheels and spade lugs are superior performers on wet padi land. On Koronivia Experiment Station under normal ploughing conditions a tractor with rubber wheels has managed with efficiency a heavy disc plough.

Several recent developments in the intermediate class of tractor include a wide range of interchangeable implements associated with a tool-bar attachment to the tractor, hydraulic implement lift and such indispensable units as portable saw bench and post-hole borer which, incidentally, can be used as a planting tool.

For the small producer there are a number of lower powered units which at first sight would appear to be adaptable to his requirements. It is important to remember, however, that much of this equipment has been produced for the horticulturalist and market gardener of temperate countries and is unsuitable for general agricultural practice by the small holder in the tropics. As a low power unit for spraying and dusting work, or for the specific purpose for which it was developed, the small machine will give good service; it cannot be expected to plough or cultivate heavy land or replace a heavier machine simply because the area is much smaller in extent.

There are, of course, certain limitations to the use of mechanical equipment in the tropics. The capital investment in the high powered class is heavy and it is unlikely that such equipment will be available except where contracts can be arranged.

Even where the capital cost is within the range of the planter there are other difficulties which must be overcome. The operation and maintenance of mechanical equipment requires a degree of skill not readily available in tropical countries; spare parts are sometimes difficult to obtain and repairs are costly unless they can be carried out on the spot.

There is the matter also of the suitability of the equipment for tropical conditions, and without advice the planter or small farmer is faced with an imposing list of designs and performance records from which to choose. Mechanical equipment deteriorates rapidly under humid tropical conditions and from the rough handling of unskilled or semi-

skilled labour. Above all, the special difficulties and problems of tropical agriculture demand specially designed equipment, both for land preparation and cultivation and the processing of agricultural products.

The studies which are now being conducted will do much to eliminate types of equipment unsuitable for tropical agriculture and will suggest improvements or modifications to existing types, or new designs. Agricultural Departments will need to give more attention in the future to problems of agricultural engineering, not only in the accepted fields of irrigation and drainage but also in the testing and designing of equipment suitable for the planter and the small farmer.

There is no doubt that greater efficiency in production and greater economy in the use of labour will follow the more general adoption of machine aids in tropical agriculture. Improved social services and better standards of living can only be attained by diversification of agriculture and by greater production. Labour saving devices, where practicable, will help considerably in this way and add their quota to the agricultural progress that has been made in plant breeding, and disease and pest control.

In Fiji some attention has been given to this problem by the Agricultural Advisory Council and Government has consented to the acquirement of a range of tractors and tractor equipment for testing and demonstration in the Colony. Experiments which are taking place in Malaya and elsewhere are being closely followed by officers of the Department and developments of importance to Fiji will be brought to the notice of planter and farmer in the pages of this *Journal*. —W.J.B.

STAFF NOTES

Mr. L. W. Harwood, Agricultural Officer, North, left the Colony on leave to Australia on 13th April, 1949.

Mr. C. R. Vasey, Senior Agricultural Assistant, was appointed to act as Agricultural Officer, North, with effect from the 13th April, 1949.

Mr. A. D. Mercer, Weed Control Officer, was appointed to act as Agricultural Officer, South, with effect from 25th October, 1948.

Miss M. V. Branster, B.Sc., was appointed Temporary Laboratory Assistant with effect from 16th May, 1949.

Dr. W. J. A. Payne, M.A. (Cantab.), Dip. Agric. Sci. (Cantab.), Ph.D. (Glasgow), was appointed Animal Husbandry Officer with effect from 11th June, 1949.

On 10th June, 1949, a farewell gathering of members of the staff marked the departure on retirement leave to South Africa of Mr. S. E. H. Coster, Assistant Agricultural Officer. Mr. Coster joined the Service in 1927 and leaves behind him a record of over twenty years' service as Inspector of Plantations and Agricultural Assistant in the Department.

Mr. K. J. Garnett, Veterinary Officer, Western, recently spent a month in Australia studying the latest parasitological survey techniques employed at the McMaster Laboratory in Sydney and the Veterinary Research Station at Yeerongpilly, Brisbane.

The investigations planned to be carried out over the next four years will give information regarding the seasonal incidence, age susceptibility and pathological levels of infestation of internal parasites in cattle so that a reliable drenching and control programme can be formulated.

IMPROVING RICE CROPS

The local retail distributors of Weedone, the hormone selective weedkiller, report increased sales this year to Fijian and Indian rice farmers who have learned of the trials made by the Department of Agriculture during 1947 and 1948 when the efficiency of this and other hormone substances was demonstrated. The work of controlling such broadleaved weeds of ricefields as Pickerel weed, tarweed, water hyacinth and primrose-willow is made much easier by the use these sprays: and there are indications that rice yields are improved by the treatment. The actual increase in yields is to be measured in trials planned during the current season. —B.E.V.P.

AGRICULTURE . . .

SOIL CONSERVATION ON PEASANT FARMS

BY SHIV NANDAN, FIELD ASSISTANT, NADI

Contouring, though of great importance in farming, is, at present, more or less ignored by many peasant farmers in Fiji. It may be because they are not fully aware of the real value it renders towards the prevention of soil erosion. Every year a great deal of damage to soil is being witnessed. In many places even gullies have been formed, but so far no step has been taken by the farmers themselves to fortify against this evil.

It is not very uncommon to see farmers ploughing their hilly land up and down the slope. Planting of crops, such as peanut for instance, in rows running down the slope is also a common practice amongst them. As a result, during the rainy season extensive damage to soil occurs by gully erosion. If the soil on a gentle slope is ploughed and left, sheet erosion may be brought by heavy rain which results in the loss of much of the surface soil. Thus, after the surface soil has been washed away for two or three years, the land loses its fertility. Soon it becomes unproductive and has to be abandoned.

Another important point worthy of mention is that while transporting the plough to and from the field, generally a furrow is ploughed irrespective of direction, which becomes the starting point of erosion. This is a common habit amongst farmers and cannot be sufficiently condemned.

In places, the farmers have made attempts to prevent soil erosion by building up bunds according to their own ideas. Sometimes the bunds run straight up and down the slope, and do not serve the purpose of conserving the soil. Some bunds are made across the slope, but without regard to the contour of the land, and Vetiver grass planted along them. These, too, are not as effective as might be. Through soil erosion the incomes of the farmers decrease. The situation is aggravated by the practice amongst Indian farmers of not making use of manures available at the farm. It is surely for the benefit of the farmers that the Department of Agriculture is taking such an active part in contouring their land to prevent soil erosion, and urging them to construct manure pens from which large quantities of valuable manure may be turned out each year.

CONTOURING PROJECT.

Contouring may be a new practice in Fiji, but in India, China, and other countries, it has been used for a long time. Hill slopes were terraced along the contour. The tea plantations of Ceylon and rice fields of Japan are note-worthy instances.

In the Western Division, when the question of contouring was first considered, the farmers were not convinced, and refused to have their farms contoured. After long persuasion and by demonstrations in school-gardens and occasional farms their confidence was at last won and their co-operation with the Department of Agriculture was secured. At important places contour bunds were made to demonstrate to the people and these have served their purpose well. Having seen the value of contouring in those places, the farmers were highly impressed. Since then request upon request has been received by the Department of Agriculture from the farmers for advice and laying out of contour lines on their farms. The writer feels proud to observe the rapid progress made by the farmers in the short time, by adopting soil conservation methods recommended by the Government. On 29 farms in the Nadi district contour lines are functioning to the entire satisfaction of the farmers. The popularity of contouring is definitely on the increase.

This is an analysis of contouring done in the Nadi district up to the present:—

No. of farms on which contour lines were marked	33
No. of acres marked	142·35
Total No. of acres with contour lines working (not completed)	47·85
Total No. of acres completed ..	14·5
Total No. of acres marked but abandoned	17·2

Further requests have been received from five farmers for the extension of contour bunds previously made (19 acres), and approximately 54 acres of new land to be contoured. Fifteen new farmers are eager to have 172 acres of land contoured. This is an encouraging sign and demonstrates the increasing popularity of contouring projects in Nadi.

CONSTRUCTION AND COST OF CONTOUR BUNDS.

At first the contour lines are laid out. The construction of bunds from both the sides can be done to some extent with a mould-board plough. The soil obtained from the first furrow should be deposited at a distance of about 18 inches from the pegs. The soil from the second furrow on the opposite side is thrown in the same way, but in the opposite direction. This gives a total width of three feet to the bank at the bottom. Then the furrows are ploughed on both sides of the bank alternately and the soil is deposited on the bank from each side with spades or shovels. After repeating the process six or eight times, it gives the bank a rise of approximately 1½ to 2 feet which is sufficient to withstand the menace of running water on a slope of less than 10 per cent. On the upper side of each bank a shallow ditch is formed which would carry away the water. This ditch must be maintained always.

Cost.—The following is an estimated cost of constructing contour banks. In Nadi 1,795 yards of contour banks on 5½ acres were constructed in medium loam soil by:—

25 units at 5s. a day	£6	5	0
1 pair of bullocks for 4 days at 5s. a day	1	0	0
	£7	5	0
Cost per acre	£1	6	4

This is only a rough estimate. The cost of maintaining the bunds and planting of guineagrass and elephant grass on them is not included.

It would be advantageous if groups of farmers co-operated with each other in constructing the bunds. Much time would thus be saved and the outlay of capital would be reduced to a minimum. The co-operation of neighbouring farmers has another great advantage. It is often necessary to provide an outlet for water from one farm through another and again it is often found that two or more farms have to be treated as one contouring project. Under such conditions co-operation is absolutely essential.

Contouring not only prevents soil erosion, but conserves moisture in the soil during dry spells or in dry zones. The resulting crop is naturally better than otherwise would have been the case.

The most suitable time for construction of contour bunds is during the dry months, when all the rice has been harvested. The farmers have more leisure then, and are able to devote some of it for this purpose. Bunds constructed at this time naturally become consolidated before the beginning of the following rainy season so that loss from break-through is reduced to a minimum.

In order to make the bunds still stronger, the planting of certain grasses like guinea grass or elephant grass is recommended. This should be planted on the bunds. The roots of these grasses help to bind the soil and keep it in position. Moreover such grasses can be used for feeding livestock.

After the contour banks are made, it is advisable to take proper care of them. They should be inspected occasionally, and breaks repaired as soon as detected. Ploughing should be done roughly parallel to them. If the land is ploughed straight up and down the slopes without regard to the contour of the land each furrow becomes a potential source of erosion.

After the construction of the bunds, careful attention during the first few rainy periods is necessary. While examining the banks, the lower parts, where there is a concentration of water, should be raised to prevent overflow.

If enough attention is not given to the conservation of the soil by the farmers now, the future generation will suffer. The farms cannot produce the same yields of crops year after year if the food used up by the plants is not replaced. While the members of the family are increasing in number, the yields of the crops obtained from the farm are decreasing, and so it becomes impossible to feed the increasing number of hungry mouths

from the reduced production from the farms. Now is the time to fortify against evil by not only making suitable provision against the loss of the soil but actually by increasing its productivity by means of manuring and suitable rotation of crops. Much valuable manure can be made on all farms where live-stock are kept by building and bringing into proper use pen-manure sheds, introduced by the Department of Agriculture.

The farming community is advised to adopt the beneficial soil conservation methods described in this article, and they are assured that if properly carried out and maintained they will not only reap great benefits themselves but will leave their farms in a prosperous condition for their descendants.

DEVELOPMENT OF AGRICULTURE IN THE COLONIES

Extract from an address by Mr. G. F. Clay, C.M.G., O.B.E., M.C., Agricultural Adviser to the Secretary of State for the Colonies, given at the opening of the Second Course at the Summer School, St. John's College, Cambridge, on the 11th September, 1948, on the organizational development of peasant agricultural production in the Colonies.

" We should be bold in our conceptions and courageous in our experiments at establishing an organization of peasant production which lends itself to the adoption of modern methods, to specialization within a community and a far greater output of agricultural wealth per unit of manpower than has so far been considered possible within any reasonable time. . . .

For successful development four things are necessary:—

(1) A system of land tenure which, whilst ensuring in perpetuity the right of occupation of the land to a community or a group of people, allows of individual tenure of some part of the commonly held land, with such safeguards as are necessary, and thus creates a pride of possession and a sense of security in the community and in the individual members of the community so framed that a system of compact holdings is maintained as an essential feature of the system and fragmentation becomes impossible.

(2) An organization of the lands of such a community which, whilst following the best precepts of land utilization, can provide for the maximum efficiency of production and the incorporation of modern aids to production.

(3) The development of a community so as to allow of specialization within the life of the community and providing scope for the more progressive members of the community to satisfy their ambitions within the community instead of having to remain as members of a one grade society or leave it.

(4) Adequate capital resources to enable the organization to be established and function efficiently.

The view has been expressed by Sir Phillip Mitchell, Governor of Kenya, that we shall make little progress by trying to persuade existing complex rural communities in the Colonies to adopt this pattern of development by voluntarily agreeing to a reorganization of their existing holdings, but we shall have to set up new communities of this pattern in areas in the Colonies at present uninhabited or sparsely inhabited and demonstrate the actual pattern of development on the ground."

THE BOTANICAL GARDENS

An interesting note connected with Mr. J. W. Parham's article on " The Botanical Gardens, Suva ", published in the last issue of the *Journal*, has been received from Mr. Alport Barker. Mr. Barker writes: " Concerning the establishment of the Gardens—Following Horne's visit, a small 'garden' of exotic trees and shrubs was established by J. B. Thurston (then Mr., afterwards Sir), who was not Governor at that time but ' Officer administering the Government ', from 1879 to 1883. The gardens were located, if my memory is correct, on the grounds to the west of Sir Maynard Hedstrom's present line. From there many of the trees were transplanted to the present site."

ANIMAL HUSBANDRY . . .

THE BEEF CATTLE SITUATION

BY C. R. TURBET, B.V.Sc., M.R.C.V.S.

No doubt readers of the Journal would welcome a statement in regard to the beef cattle situation in the Colony for there is no doubt but that the numbers of cattle are declining. Unfortunately this falling off in numbers of cattle is occurring at a time when the human population of Fiji as well as the numbers of consumers of beef are increasing. For the time being therefore the condition of previous oversupply of cattle has been changed to one of undersupply. The country is now hard put to it to find enough beef to satisfy the growing beef hunger.

Fortunately our good neighbour, New Zealand, has been able to supply for our needs a fair quantity of fresh meats but we have to remember that any meat made available to us from New Zealand is apt to decrease the supply which would be available for the many millions of people in Europe and Asia who are much worse off than we are in regard to food supply and particularly to meat foods.

It has not been possible to make a census of our cattle population in recent years but in 1942 the Veterinary Division of the Department of Agriculture carried out a count of animals which revealed the following numbers:—

Bulls	4,769
Cows	36,944
Bullocks	26,945
Young stock	15,686
Total cattle	84,344

At this time a similar count is actually being made but with the reduced staff available progress has not been as rapid as was expected. Nevertheless it is anticipated with confidence that the figures will be available for the next issue of the *Agricultural Journal*. We shall then know with reasonable accuracy the extent of the decline in our cattle population.

Accurate records of the killings of cattle in registered slaughter houses are kept and the figures for the last ten years are given with the figure for 1949 estimated on killings to date. These figures are:—

1939 ..	4,294	1944 ..	4,329
1940 ..	4,315	1945 ..	5,240
1941 ..	7,052	1946 ..	7,745
1942 ..	8,051	1947 ..	9,364
1943 ..	5,240	1948 ..	6,304
		1949 ..	5,285 (estimate)

It is impracticable to record killings in villages and on plantations (for labour) but the total consumption in this manner is believed to be considerable. A proportion of the hides from cattle killed in villages and on plantations and all of those from registered slaughter houses are exported. It will be seen that the numbers of hides exported give a better idea of the total numbers of killings than do the figures from killings in registered slaughter houses alone. The numbers of hides exported annually for the last 10 years and estimate for 1949 are given below:—

HIDES EXPORTED.

1940 ..	6,289	1945 ..	8,942
1941 ..	5,757	1946 ..	8,258
1942 ..	9,077	1947 ..	12,411
1943 ..	6,404	1948 ..	9,759
1944 ..	3,773	1949 ..	8,500 (estimate)

THE CAUSES OF DECREASE IN CATTLE.

Enterprise in cattle raising was destroyed as a result of the effects of a long period of depressed prices for beef cattle which made beef cattle raising unprofitable except as a side line. In the period before the war the price of beef cattle was based on a valuation of between 22s. 6d. to 30s. per hundred pounds dressed weight of the carcass. A prime bullock of 600 lb dressed weight had a gross valuation of from £6 15s. 0d. to £9. From this sum the cost of freight and or droving to the slaughter house had to be deducted. It will be seen therefore that there was little if any profit in cattle raising.

The only producers who could get any profit out of the industry were firstly proprietors of butcheries who produced some of their own cattle for sale through their businesses; coconut planters to whom cattle were valuable for keeping down undergrowth on the plantation, the annual surplus

being disposed of to the butchers; dairy farmers who disposed of their culled cows and a few odd bullocks and the peasant farmer who was able to dispose of old working bullocks as young ones became available to replace them as a result of the growing up of the calves of his domestic cows.

Prices of cattle are now remunerative but producers are unable to take full advantage of a good market because of other factors which have developed and which are discussed below.

There are now fewer Europeans engaged in cattle production. In this connexion the earlier European colonists were, for the most part, men of vision, energetic, enterprising and knowledgeable in regard to the principles of cattle production. They are being replaced on the land by peasant farmers and people of other races who lack capital, enterprise and knowledge of the work.

Because of the general pressure of closer settlement and the utilization of the more fertile lands for arable crops, less good land is now available for cattle production. Good beef cattle cannot be raised on poor land and to finish them off as fats, good pasture such as grows only on fertile soil is needed. Such land is becoming more difficult to obtain for cattle raising.

There is the uncertaintly also of land tenure due to the delays in the demarcation of reserves, in the confirmation of existing leases and approval of new leases applied for. With this is associated the pressure on the part of many Fijian owners to repossess their lands. Because of these difficulties which are occurring now (but which it is hoped will be overcome shortly) owners of leases are disinclined to carry out the improvements necessary to put their lands into a state suitable for profitable cattle production.

It was mentioned earlier that dairy farms provide a considerable number of cattle to the beef supply. Unfortunately the multiplication of numbers of cattle on dairy farms has been retarded, partly because of excessive calf mortality on some farms. This is due often to faulty calf husbandry. It must be admitted however that there is at times great difficulty in raising calves owing to adverse environmental factors caused by unusually wet seasons, malnutrition of the adult stock and vitamin deficiency in their milk which is passed on to the calf and, finally, infection with worm parasites. In this connexion the warm humid conditions existing in Fiji are particularly favourable to the occurrence of worm parasites so that the hazards of calf raising are enhanced on this account.

Whilst the feeding of concentrates is not practiced in beef cattle raising in Fiji, the low availability and high cost of suitable foods for dairy cattle and for calf raising act as limiting factors in cattle production on dairy farms.

During the war period and in the following years fencing fell into disrepair. Owing to the difficulty of obtaining and high cost of material it has not been possible for cattle owners to maintain their fences or to erect new fencing so that control of cattle and of pasture rotation became almost impossible. The fencing difficulty has been a major problem in maintaining cattle production.

Unfortunately the spread of noxious weeds has reduced the carrying capacity of many thousands of acres. Valuable pasture has been replaced by inedible weeds. This situation has come about because of several factors. Firstly the warm humid environment is particularly suitable to the rapid growth of certain weeds. Overgrazing of pasture when we had a surplus of cattle resulted in the eating out of valuable species and so allowing room for the expansion of weeds. At the same time in the period just prior to the war the proceeds of the sale of the products of the land, coconuts or cattle, did not provide sufficient income to pay for labour to control noxious weeds and maintain pasture and so a vicious circle developed which is now being found most difficult to break.

Although the labour strength of the colony is better now than during the war period, wages are almost doubled and the cost of weeding is so high, that it cannot pay to clean most of the grossly weed-infested poor land for grazing purposes. On coconut estates, which were at one time the principal source of beef cattle for Suva, the high value

of copra causes the planter to concentrate all available labour on cutting this product so that once again the control of weeds and the provision of pasture for cattle on coconut estates is relegated to the background.

There is another aspect of the labour situation on coconut estates. Estate labourers are content to cut copra for three or four days in the week on contract rates. They earn sufficient money in this time to provide them with all their needs. The result is that they are disinclined to undertake the monotonous and continuous labour of weeding even when the plantation owner is eager to employ them on this work.

Finally the increased desire for consumption of beef by Fijians and part-Europeans since the war period has caused a heavy drain on available supplies.

IMPROVEMENT MEASURES.

Most readers will be aware that a plan for the developing of a large scale cattle raising scheme in Ra was given very close study by a Government appointed committee. At first sight there seemed to be a reasonable chance of the successful development of the scheme. In fact it looked so good that the Colonial Development Corporation in London sent out Mr. W. Reece, a cattle ranching expert, to report on the scheme or to submit alternative proposals with a view to the Corporation putting up the necessary funds.

Unfortunately it appears that Mr. Reece's report indicated that the prospect of the development of a successful and profitable cattle raising scheme based on the likely value of beef cattle in Fiji were not good enough to induce the Colonial Development to put up the money and go on with the scheme. This being the case, it is unlikely that any other organization will be prepared to put up the capital necessary for the establishment of large scale cattle ranching in Fiji.

The best that can be done therefore is to foster, by all means, the existing organizations for cattle raising. Having discussed in the foregoing paragraphs the reasons for the decline in beef cattle production, it is logical that measures to be adopted to effect improvement should aim at the elimination of adverse factors or the amelioration of such conditions.

THE PRICE OF BEEF CATTLE.

The first incentive to greater production of beef cattle is that the cattle raiser must be assured that he will receive a fair reward for his efforts, his capital investment, and cost of maintaining his property. In other words he needs an assurance that the price of beef cattle will not fall below a remunerative figure for a given number of years.

This may be done by one of two methods, firstly by the fixing of controlled prices for graded beef based on the dressed weight of the carcass on slaughter and related to the retail price to the consumer, or alternatively by Government guaranteeing by subsidy, if needed, the minimum prices for graded beef based on dressed weight of the carcass.

Under the first method it is certain that an increase in the retail prices of better grades of meat will come about. It is necessary that such prices remain under control. The second method would operate in event of the retail price being controlled and subsequently falling. It may be necessary then to maintain the prices for carcasses by subsidy. It is not certain however that such action would be needed because the demand for beef both in Fiji and world wide promises to become greater rather than less because of the rapidly increasing world population.

GRADING OF BEEF.

There must be an incentive for the cattle farmer to produce better beef. The farmer who by reason of his greater skill, greater expenditure of money in pasture and farm maintenance and by owning better stock, is able to produce prime animals for slaughter for meat, should be paid more for his cattle than is received by the farmer who produces poorer cattle at lesser cost. In other words grading of beef is needed. This can be done by the existing staff of Government meat inspectors after tuition, provided their numbers are maintained.

It is suggested that three grades be recognized for the time being, as follows:—

First grade { fat steers 3 to 5 years.
fat speyed cows.
fat barren cows.

Second grade { fat old working bullocks.
medium steers.
fat old cows.
medium cows.

Third grade { working bullocks and
old cows not fat.

On grading the Meat Inspector would fix sealed tags of distinctive colour or pattern to the various quarters indicating the grades allotted.

Payment should be based on the dressed weight of the carcass as described under the Defence (Dressed Weight of Cattle) Order, 1943, as follows:—

"The dressed weight in the case of cattle shall consist of the weight of the bled and skinned carcass after removal of the head and all the organs excepting the kidneys.

When the cattle are sold on the basis of payment according to dressed weight, the value of the carcass shall be arrived at by weighing the four quarters. The sum of the weights of the four quarters shall be considered as the dressed weight of the carcass.

In removing the head from the carcass the point of division shall be between the occipital bone of the head and the atlas bone of the neck."

At this stage it is suggested that the prices per one hundred lb dressed weight should be as follows:—

1st grade 66s. per 100 lb = 8·0 pence per lb.
2nd grade 58s. per 100 lb = 7·0 pence per lb.
3rd grade 50s. per 100 lb = 6·0 pence per lb.

FENCING.

The present price of fencing wire is far too high for large scale purchases such as are needed to be made. It is suggested that some form of subsidy be payable so that the farmer is able to purchase wire at not more than £40 per ton.

Good quality fencing posts are also most difficult to obtain. The advantages of concrete posts in their durability and fire resistance are well known. It is recommended in this connexion that experiments should be carried out to determine the most economical method of manufacturing large numbers of suitable posts.

The most bulky material in concrete posts is the sand and gravel. The posts should be made therefore at the point of nearest accessible supply of this material. The cement moulds and reinforcing material would need to be transported to that point. By using numerous moulds and mechanical mixers the cost of producing posts should be brought to a minimum figure capable of being lessened as the post makers gain skill in operation. It may be necessary even to subsidize their manufacture so that the cost per post does not exceed 4s.

NOXIOUS WEEDS.

The problem of the control of noxious weeds on pasture lands and on plantations is formidable and is receiving the attention of the Department of Agriculture. One should not forget the remarkably successful control of the weed *Clidemia hirta* which was brought about by biological control through the introduction of the thrips *Liothrips urichi*. The possibility of further controls is being continuously studied by the Government Entomologist. The attack on weeds is being pursued also by the employment of chemical weedicides and by cultural methods. Spectacular results such as occurred with *Clidemia hirta*, however, are not to be expected to be repeated with each and every variety of weed. At this time one should not anticipate easy control but should on the other hand be prepared for heavy expenditure of labour and cash.

PASTURE IMPROVEMENT.

The pastures which occur naturally in Fiji have in the past produced large numbers of prime beef cattle. At this time thousands of acres of pasture have been given over to noxious weeds. If the weeds are eradicated there will be a return to the naturally occurring pasture without very great expenditure on pasture improvement. By this measure alone much improvement in pasture will be achieved. Cattle producers however should not be content with this but will need to introduce such new species and methods of culture and control as are recommended by the Department of Agriculture whose officers are always prepared to advise.

In addition to the grasses, legumes and other edible herbage need to be introduced and fostered since in the nutrition of cattle a good balance of diet is best obtained by providing variety in the pasture and including the protein-rich legumes such as the

Fiji trefoils (*Desmodium* spp.). The Department of Agriculture has under observation several pasture and fodder plants newly introduced to Fiji and it is expected with confidence that some of these will prove to be good additions to our pasture or fodder supply.

In order to get the best results from the grazing of cattle it is necessary that the available area be subdivided into conveniently sized paddocks by substantial fencing. What is known as rotational grazing is then practiced. Grass is most nutritious in the young stages of its growth before the plant flowers. The rotation of the cattle through the different paddocks needs to be planned so that each field is eaten out whilst the grass is still young.

Considerable skill in management is needed to control rotational grazing efficiently. A most important requirement is that the land will be stocked with just the right number of cattle. If too many, the grass will be so eaten up that recovery rate will not be quick enough. If too few, the grass will grow more quickly than it can be eaten up. The result will be that some of the grass will become too mature. The quantity of indigestible crude fibre will increase and the nutritive qualities decrease.

Where it is possible to cultivate pasture land this practice is desirable after several years of grazing. It is most economical to plant some kind of crop for a year or so and then to allow the land to revert to pasture. By this arrangement a money crop may be obtained to pay for the cost of cultivation. The area which may be cropped, however, is very small in relation to the total grazing area. Other useful operations in maintaining a high nutritional value in the pasture are mowing and the use of artificial fertilizers.

LAND FOR CATTLE RAISING.

The Native Land Commission is aware of the need for hastening the demarcation of reserve lands. When this work is completed and it is hoped that it will be soon, decisions may be given in regard to applications for the extension of grazing leases as well as for leases of new land. In the meantime, no doubt, the Native Land Trust Board will see its way clear to deal at once with such applications, where the land concerned is unlikely to be within a reserved area.

On lands where there is no alternative to widespread communal grazing it is suggested that an area supervisor, a local resident, might be appointed to control the grazing of the land in the locality. It would be necessary to erect a mustering yard with wing fences. The Branding Ordinance should be enforced and the ownership of all cattle established. Unclaimed cattle should be sold at six monthly intervals by public auction. A grazing fee should be charged and collected by the Supervisor and paid to a fund. Each supervisor would be controlled by the district Livestock Officer of the Department of Agriculture, who would also determine the number of animals which might be grazed in any locality so that overgrazing would be avoided.

DISEASE AND PARASITISM.

The Veterinary service of the Colony will continue as before to give close attention to the control of such diseases of cattle as exist. Particular attention is being paid to the problem of infestation with worm parasites and a survey is planned to determine the seasonal variation in the incidence of worm parasites as well as the degree of infection so that treatments may be timed to secure the maximum effect. In this connexion Mr. K. J. Garnett, B.V.Sc., was sent recently to Australia by Government to obtain personal experience of the methods being adopted in that country. Suitable equipment has been obtained for the work. Unfortunately this investigation is held up owing to shortage of veterinary staff.

PROPOSED CALF SUBSIDY.

It has been proposed, and Government has under consideration, that a subsidy be paid to the owners of registered dairies for those calves raised on their dairies additional to the average number raised annually during the past three years and in proportion to the number of cows in the herd.

ENCOURAGEMENT OF BEEF CATTLE RAISING.

In the meantime the Extension Service of the Department of Agriculture is carrying out a vigorous campaign among existing

farmers and plantation owners with view to encouraging them to engage in cattle raising to a greater extent. Greater production by the small farmer or plantation owner is possible and is to be expected.

CO-OPERATIVE PRODUCTION BY FIJIANS.

A difficulty experienced in the past by Fijian who attempted to engage in cattle raising on his own was the practice of *kerekere*. There was no incentive for him to continue when he found that the majority of his cattle were disposed of according to custom freely to his friends and relatives. It seems likely that if co-operative ownership could be established together with co-operative marketing by groups of Fijians it would be possible for Fijians to engage in cattle raising for profit.

CATTLE SALE YARDS.

No proper organization exists in Fiji for the sale of cattle. In other countries livestock sale yards exist and perform an important function in rural life. It has been found that when livestock sale yards are established in centres of rural populations they become important centres for all other trades and occupations as well as social intercourse. For example in Europe the marketing towns appear to have been developed around the livestock markets. More recently we have had news from Uganda of the development of big business centres around cattle markets which were established within the last few years by Veterinary and Livestock officers acting entirely on their own initiative without official government support in the first instance. These stock sale yards have proved a phenomenal success.

The existence of a well organized and remunerative market for cattle is a prerequisite to the expansion of interest in cattle raising. It is hoped therefore that within a few years well organized livestock sale yards will come into existence.

In conclusion it is hoped and expected that all livestock owners will make a special effort in the next few years to increase the numbers and quality of their cattle as a means to ensure an ample supply of food for the people of Fiji and incidentally to improve their income from this source. In this connexion also it must be remembered that the world population is increasing at the rate of about 20,000,000 annually. If famine is to be avoided it is necessary that more and more food be produced. I am sure that the people of Fiji will not be found wanting in the production of food for the people of the world.

MODERN METHOD OF GHEE MANUFACTURE

Readers of the *Journal* will be interested to learn of a fairly recently introduced method of ghee manufacture. It is done by the use of a " Purification " separator very similar to that used to separate cream from milk.

In the process butter without the addition of salt is first made by the usual method. It may be kept in bulk in a cold store until ready for separation.

The additional equipment needed consists of a rustless steel box about three feet long by eighteen inches square at the end. The box is open at one end which is elevated some six inches higher than the other end of the box. Steam jets enter the box from below and from the sides.

Butter to be converted into ghee is first placed in the box and the steam jets are turned on so that the butter is melted into a fluid state. The fluid butter then gravitates into the " Purification " separator. In this machine the water in the butter is separated from the butter fat. The solids of the butter remain in the bowl of the separator and accumulate there so that it is necessary to clean the bowl after a period of operation.

The butter fat (ghee) purification separator is manufactured by the De Laval Company whose cream separators are so well known to dairy farmers. Machines are available in sizes capable of handling from five gallons of melted butter up to one ton per hour.

The cost of the machine and accessories is too great to warrant its purchase and use by small farmers but for a large farm or butter factory the installation of the equivalent would be well worth while for it supplies the answer to the problem of economical manufacture of ghee. —C.R.T.

EGG PRODUCTION RECORDS

BY C. R. TURBET, B.V.Sc., M.R.C.V.S.

Very few records have been published of the egg yields of fowls in Fiji. It may be of interest to poultry keepers therefore to have the results obtained from the flock of the writer between June 1941 and May 1944.

These birds were well-bred Australorps of the same strain as those kept at the Nasinu farm, which was at that time maintained by the Department of Agriculture.

Their pen run was one square chain so that they were never overcrowded. In addition they were allowed free range almost every afternoon. They were allowed ample house space and nesting accommodation. Periodically they were inspected for lice and treated by dipping once annually. They were also treated for worms about once annually.

The increase in the average number of fowls per month was due to pullets coming into lay. Decreases were due to disposals. Only three deaths occurred in the three years.

It is difficult to record their ration because of the irregularity of food supplies during the war period. Coconut meal was obtainable at all times and constituted on the average about 20 per cent of the ration but at times it was necessary for short periods to feed only coconut meal. " All Mash " was used when obtainable. At other times pollard and maize meal were available for months at a period. Rice meal was not in favour owing to the admixture of hulls but nevertheless at times it had to be used. A windfall in 1943 was the obtaining of a supply of condemned army biscuits which when soaked with coconut meal make a fairly well balanced ration. Some skimmed milk was available each day. There was never sufficient grain to feed a daily ration so that it was necessary to feed two mash meals daily. These were always wet mashes. Some army swill containing meat was occasionally available. Shell grit was supplied at all times.

When making home brewed beer, the dregs of the brewing vat, rich in Vitamin B, was always added to the mash.

The above will give an idea of the feeding arrangements. It will be seen that the scientific principles of poultry feeding could not be followed. Nevertheless every effort was made to balance the ration daily according to the feeds available on that day. In fact the conditions were very similar to those met with from day to day by any other poultry keeper in Fiji.

The egg yield obtained is such as might reasonably be expected by any other owner of a small domestic flock and will serve as a standard for comparison.

To keep the record one foolscap sheet is needed annually. It is divided into thirteen vertical spaces, one being to write in the day of the month from 1 to 31 downwards and one column for each month of the year. Across the page at the top, the month is written over the appropriate column using three letters, as Jan., Feb., Mar., etc. Immediately under this a line is reserved to record the average number of hens in the flock during the month. For instance if there are eleven birds on the first of the month and one dies on the 15th day leaving ten birds for the balance of the month, the average number of hens is 10·5. The figure can be worked out for any other set of circumstances.

In the left-hand vertical column 31 lines are numbered from 1 to 31 from above downwards. The transverse line immedately under the 31 line is for the monthly total. The line below this is for the average monthly yield per hen and finally at the bottom of the page you write in the average yield per hen per annum.

Poultry keepers will find added attraction in poultry keeping if such a record is kept. One can see at a glance how the flock is progressing. Variations from the standard given in the statistical record given in this article will need to be investigated as to the cause.

EGG PRODUCTION RECORDS.

Period.		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Average yield per annum per hen.
June 1941 to May 1942	Average No. of hens	15	9·1	10·5	11·5	13	12	12	12	12	12	10·4	13	
	Monthly egg totals	305	208	143	202	238	182	162	114	79	140	150	183	
	Average monthly yield per hen ..	20·3	22·8	13·6	17·5	18·3	15·1	13·5	9·5	6·6	11·6	14·4	14	177·2
June 1942 to May 1943	Average No. of hens	18	34	34	32	32	30	26	24	24	30	37	39	
	Monthly egg totals ..	176	535	486	449	356	178	307	223	216	293	341	350	
	Average monthly yield per hen ..	9·8	15·7	14·3	14·0	11·1	6·0	12·0	9·3	9·0	9·7	9·2	9·0	129
June 1943 to May 1944	Average No. of hens	57	58	56	56	54	52	50	42	30	17·5	17	15	
	Monthly egg totals ..	708	783	743	764	602	587	452	295	255	158	187	215	
	Average monthly yield per hen ..	12·4	13·5	13·2	13·0	12·04	11·3	9·0	7	8·5	9	11	14·3	134·2
Mean average monthly yields per hen for three years.		14·1	17·3	13·7	14·8	13·8	10·8	11·5	8·6	8·0	10·1	11·5	12·4	146·6 = Mean average yield per hen per annum.

ECONOMIC BOTANY . . .

PLANT PROTECTION IN SOUTH-EAST ASIA AND PACIFIC TERRITORIES

BY B. E. V. PARHAM, O.B.E., M.A. (HONS.)

In recent years the spread of plant pests and diseases through the world has become a matter of gravest concern to agricultural authorities whose fears have, since the last war, been proved only too well founded. The subject has received the urgent attention of Pacific scientists at the Seventh Pacific Science Congress held in New Zealand in February; at the meeting of the Research Council of the South Pacific Commission held at Noumea in May; and in South-East Asia a special Phyto-Sanitary Conference was held during April at Singapore.

Fiji was invited by the Secretary of State to participate in the last named conference and as it was considered that the Colony is vitally concerned in any measure adopted to improve plant quarantine and protection services in the Pacific region, it was decided to arrange for Mr. R. J. A. W. Lever, late Entomologist, Department of Agriculture, Fiji, to attend on behalf of the Fiji Government.

The following countries and organizations were represented: Australia, Brunei, Ceylon, Fiji, Hong Kong, India, Indo-China, Indonesia, Federation of Malaya, Sarawak, Singapore, United Kingdom, United States of America, United Nations, South Pacific Commission and the Rubber Research Institute of Malaya.

The Chairman was Dr. H. W. Jack, former Director of Agriculture, Fiji, and now Agricultural Adviser to the Commissioner-General for the United Kingdom in South-East Asia.

The Conference recommended *inter alia* that—

1. A Plant Protection Convention for a definite area be concluded. This would be known as the South-East Asia and Pacific Phyto-Sanitary Convention.

2. All plant material responsible and spread of pests and diseases should come within the scope of the Convention.

3. A permanent commission, with a permanent centre of information in London, should be formed to advise on matters relating to plant quarantine and plant importation and to assist in the distribution and co-ordination of common measures of protection against and control of plant pests and diseases throughout the South-East Asia and Pacific region.

4. Each country should prepare and maintain a list of plant pests and diseases which occur already in its territory and also a list of major pests and diseases, it is considered should be included. A similar resolution was recorded by the Committee on Organization of Research of the Seventh Pacific Science Congress.

5. Each country should establish its own quarantine stations but potentially dangerous material should be subject to intermediate quarantine outside the region covered by the Convention.

6. Sub-regional technical committees responsible for co-ordination of work should be established in each region.

7. All signatory Governments should be asked to make regulations for the stringent control of the carriage of plants and plant material by air to, from or through their territory in the region.

8. In order to exclude South American leaf-blight of Hevea rubber* from the South-East Asia and Pacific region, Governments concerned should be asked to enact certain regulations with the least possible delay. Draft regulations for the control of traffic in plants from tropical America and for the prevention of the introduction of the serious swollen-shoot virus disease of cacao from West Africa are proposed.

* *Dothidella ulei.*

ENTOMOLOGY . . .

SOME INSECT PESTS OF TONGA

BY B. A. O'CONNOR, B.A., B.Sc. (AGRIC.)

This outline of the insect pests of the Kingdom of Tonga is the result of observations made during a visit lasting from April 21 to May 26, 1949. It is thus by no means a complete survey but has been compiled as a basis for the control of insect pests in the Kingdom. Apart from a short list of pests compiled by Cottrell-Dormer[3], a few references in Annual Reports of the Tongan Department of Agriculture[2,4,5,6,12,13] and some other brief observations[1,7,8,9,11,15], no publications dealing with the insect pests of Tonga have been seen.

A collection of insects was made during the tour, and records of the occurrence of various species are given below. There has not been time to submit the bulk of the material to expert taxonomists, but at a later date a supplement to this article will be prepared which will incorporate a list of determinations made by authorities, and corrections where necessary. The only insects mentioned in this paper which have been named by experts are the Aphids, kindly identified by Dr. W. Cottier of the Plant Diseases Division, D.S.I.R., Auckland, and the ant *Solenopsis geminata* Fab., var. *rufa Jerd.*, kindly determined by Mr. J. Clark of Melbourne by courtesy of Mr. T. Greaves, Research Officer, C.S.I.R.O., Canberra.

INSECTS OF THE COCONUT PALM.

The Coconut Stick Insect (*Graeffea crouani*, Le Guill).—Order *Orthoptera*. Family *Phasmidae*. This insect is recorded from Samoa, Tonga, Fiji, New Caledonia, the New Hebrides, Wallis Island and Futuna Island. It devours the green tissue of the coconut leaflets and, during severe outbreaks, strips all but the few youngest fronds which are then very reduced in size. Ultimately the palm may die. Other food-plants, recorded by Lever,[10] are *Pandanus tectorius* and the reed *Miscanthus japonicus*. An excellent coloured plate of the adult male insect has been published by Simmonds.[14] *G. crouani* occurs throughout Tonga, but seldom in such numbers as to constitute itself a serious pest. Locally it is stated that severe infestations follow periods of dry weather.

At the time of my visit the only area which was seriously affected was a plantation on the small island of Fofoa, in Vavau. Of a total area of 180 acres, about 50 acres showed the effects of extensive feeding by the stick insect. Hundred of palms in this area had been killed, many more were stripped, except for a few stunted and distorted central fronds, and the remainder retained about half or a third of their normal foliage. Estimates of the insect population were made throughout the plantation by cutting fronds and counting the insects, by having boys ascend the palms and seek them, and by counting nymphs and adult males caught on sticky bands placed round the trunks of palms. Populations were everywhere low, but much more so in the badly affected area. Catches for one night on sticky bands give an indication of the variations in population: From 40 palms in the severely damaged area—two first stage nymphs and one adult male, caught on two palms. From 30 palms, in the badly-damaged area, which still retained about one-third of their foliage—eight first-stage and one second-stage nymphs, and four adult males, caught on six palms. From 30 palms, in an area just outside the severely damaged area, with normal foliage—40 first-stage nymphs and five adult males, caught on 21 palms.

By counting the insects on fronds lowered from the palms, plus those found by the climber in the crown of palm, the following results were obtained: from five palms and 22 cut fronds in the badly damaged area, five adult males, five adult females, and no nymphs were obtained. From five palms and 31 fronds outside the badly damaged area, one adult male and seven young nymphs were taken. Of the 10 adults found in the bad area, nine were from one palm.

General conclusions reached from the counts were: (1) population throughout the plantation is low, (2) there is no sign of an early increase in population, (3) numbers of insects in the badly-affected area are much smaller than in the remainder of the plantation, probably due to lack of food. Thus the indications are that the infestation is declining and that recovery of the palms which have not been too severely damaged should take place. These conclusions were supported by the evidence of a local resident who stated that six months previously the condition of the infested area had been worse than at the time of our inspection, and it had then been possible to find large numbers of insects on the palms. Hence no immediate control measures were called for.

Description and Life-History of G. crouani.—The eggs are dropped to the ground by the female. They are from 5 to 6 millimetres long, a little more than 2 to nearly 3mm. wide, and about 2mm. thick, truncate at one end and pointed at the other. Their colour varies from pinkish to grey or dark chocolate, and they are coarsely punctate. Simmonds[14] states that their period of incubation is about three months, and the average for 19 eggs brought from Tonga to Fiji by the writer was 99 days, with a variation of from 94 to 111 days. This was during the cool season, daily mean temperatures averaging about 75°F. Observations during a short period indicate that the female lays one or two eggs nightly, averaging a little more than one per night.

The young nymph which hatches from the egg is green in colour, and from ¾″–1″ long, i.e. about four times as long as the egg. It climbs up the trunk of a coconut palm, where it feeds and grows on the fronds. Measurements of collections of nymphs indicate that there are probably three nymphal stages before the insect becomes an adult.

Adult females are about four inches long, and adult males about 2½ inches. The adults have very short wings, useless for flight. In the male, these are about ¾ inch long, and in the female less than half an inch. Hence the wings are proportionately very much larger in the male than in the female. When opened out, the membranous portion of the wings is rose coloured. The insects feed at night, and rest underneath the coconut leaflets during the day, the males usually being carried around on the backs of the females. Copulation occurs during the day or the night, and a pair remains in copulation for several hours. The colour of the adults is usually either green or a pinkish brown.

Suggestions for control.—Regular inspection of plantations, and prompt action where necessary, should make control of the stick insect a simple matter. In the case of Fofoa Plantation, failure to implement control measures in the early stages had led to severe attack over an area of fifty acres. Hence, had it been thought advisable to implement control measures, a power duster would have been necessary. However, as the insect population was so low throughout the area, and in adjacent areas, the cost of power dusting at this stage seemed unjustified. It has been decided to watch the progress of the infestation and take appropriate action as indicated.

Normally, heavy attack by the stick insect begins in a small, localized area, and it is when this is noticed that action should be taken. The measure recommended as most practicable under Tongan conditions is banding of the palms and smoking down the insects. Good commercial sticky bands are off the market at present,* so the bands must be home-made. From two to three parts by weight of resin are mixed with one part by weight of linseed, coconut or castor oil, the oil being heated and the resin added gradually until it is all dissolved. To this may be added one ounce of technical DDT per pound of banding material, the DDT being finely ground and dissolved in the warm, liquid mixture. A band made in this way is very sticky, but runs excessively during the heat of the day. However, it would probably catch insects for several weeks, and the incorporated DDT might cause the death of insects which managed to cross the band later. (It is known that DDT in a good commercial banding material killed insects which passed over it during nine months after application). Other types

* Banding material is now available in England at 2s. sterling per pound.

of material, such as heavy automobile oils and greases, are to be tried as carriers for DDT in bands, as some of these do not run. Though they do not prevent the passage of an insect, they might ensure its picking up a lethal dose of DDT, and they would be cheap, and probably last longer than the home-made sticky band.

To treat with bands an area of palms affected by the stick insect, the banding material is made up, allowed to cool overnight, and applied to the trunks of the palms by hand, a few feet from the ground. Putting the band on with the hand is the quickest and easiest method, and on completion of the work, the hands may be cleaned with methylated spirit. After application of the bands, debris from the floor of the plantation is piled into heaps between the palms, and lighted to produce smoke fires. Most of the stick insects drop to the ground and are caught in the bands when they attempt to climb up the palms. Fires should not be made against the butt of the palm as this practice, apparently common in Tonga, is injurious to the palm. In experiments carried out at Fofoa it was found that 114 lb of mixture was sufficient to place bands about three inches wide on the trunks of 300 palms. Time taken for banding the 300 palms was 11¼ man-hours. Estimated cost of banding, including labour, was 1s. per palm.

Natural Control.—There is no definite information regarding factors which influence the rise and fall of population of *G. crouani*. With caged insects, it was found that eggs dropped to the bottom of the cage by the female stick insects were devoured overnight by the ant *Tapinoma melanocephalum*, a minute and rapidly-moving species. As this ant is very common in the coconut groves of Tonga it undoubtedly must exercise some measure of control.

Agonoxena argaula Meyr.—This small moth is found throughout Tonga, the larvæ feeding on coconut leaflets, usually on the lower surface but sometimes also on the upper surface. The larvæ feed underneath a fine web and chew the green material of the leaf, producing scars which run parallel to the veins of the leaf. They pupate in a white cocoon on the leaf or on plantation undergrowth. The adult is a small yellowish moth with narrow, pointed, handsomely marked forewings. The damage done by this insect is not sufficient to call for measures of artificial control. The larvæ are heavily parasitized by a wasp, *Brachymeria* sp., of the family *Chalcididæ*.

Diocalandra taitensis, Guer.—This small weevil is found throughout Tonga, though it appeared to be more numerous in Vavau than in Tongatabu. The adult has the typical long snout of the weevil family, is about 1/5th inch in length and brown in colour, with darker markings on the prothorax and elytra. The larvæ are white, legless grubs with yellowish heads and are found boring in the midribs of fronds, in the main stalk and bases of raches of spadices and in bracts and growing tissue of the nuts. The adults are apparently attracted to sap exuding from wounds and are found in considerable numbers on the exposed surface of the midrib where a frond has been cut off or a strip of surface tissue has been removed. Undoubtedly the common practices of cutting off fronds and stripping off portions of the midrib help greatly to increase the numbers of the weevil.

This insect is not definitely known to cause any economic loss, though the feeding of the larvæ in the growing tissue of the nut and at the basis of raches on which nuts are developing, and which are often almost severed, might be expected to have harmful results. However, beyond causing surface scarring of nuts, the weevil appears to have little effect on its host. Hence artificial control measures are not indicated at present.

Scale Insects and Mealybugs.—Various species of scale insects and mealybugs—family *Coccidæ*—occur commonly on coconuts throughout Tonga. However, the populations of scale insects are very small and are obviously kept low by the activities of natural enemies. Mealybug populations are somewhat larger, but the insects appear to do little damage. In one instance, on the island of Fofoa, a palm was seen with twisted and distorted leaves, portions of the younger leaves having died. An unidentified species of mealybug occurred on the unopened central spear and younger leaves

associated with the ant *Tapinoma melanocephalum*. Many of the younger spadices of this palm had no female flowers. It is possible that the mealybug may have caused this condition. The species of *Coccidæ* taken on coconut palms in Tonga were as follows:—

Phenacaspis samoana Doane & Ferris: From midrib of leaf and stalk of spadix, Neiafu, Vavau, and from midrib of leaf, Nuku'alofa.

Chrysomphalus dictyospermi, Morgan: From large nuts, Vavau, and from raches of spadix, Nuku'alofa.

*Unidentified Diaspine Scale** Between bracts of nuts, Nuku'alofa.

Pseudococcus cocotis, Mask: From raches of coconut spadix, Neiafu, Vavau.

Unidentified mealybug: From raches, Vavau, stalk of unopened spadix, Nuku'alofa, and distorted young leaves, Vavau.

Icerya seychellarum, Westw: Coconut frond, Nuku'alofa.

There is a record of the mealybug *Ripersia palmarum* on coconuts in Tonga.[11]

Spike Moth (*Tirathaba trichogramma*, Meyr.—This moth, the larvæ of which bore in young nuts and female flowers of the coconut, has been recorded from Tonga[3,9,14] but evidence of its work was slight. On one occasion, a large larva was seen boring in a nut about four inches long on the "Taokave" type of palm at Nuku'alofa, and larvæ were taken attacking larger nuts at Vavau. Young spadices were generally singularly free from evidence of attack by Lepidoptera.

Treehoppers, family Tettigoniidæ.—Two unidentified species of Tettigoniids were taken on the foliage of palms at Fofoa, apparently feeding on the leaves, but very few individuals were seen, so that these species appear to be of no economic importance.

Promecotheca reichei, Baly.—*The Coconut Leaf Miner*, has been recorded from Tonga[2,14], but has not caused serious damage, no doubt being controlled by native parasites. In 1938, the parasite *Pleurotropis parvulus* was introduced from Fiji, but there is no record of its becoming established.

Miscellaneous.—Other insects observed on coconut palms, apart from ants, which will be dealt with later, were the Sugarcane Weevil Borer, *Rhabdoscelus obscurus*, taken on the exposed tissue of a cut frond at Vavau and a small weevil, thought to be *Meredolus cocotis*, Mshl., on male flowers of newly-opened spadices in Tongatabu.

INSECTS OF THE BANANA.

The Banana Scab Moth (*Nacoleia octasema*, Meyr).—This insect occurs throughout Tonga, and does great damage to banana fruit. Up to date there seems to have been no attempt by growers to control the pest, though arrangements are now being made by the Agricultural Department to organize control measures, with which the officer in charge is familiar. The moth, which is yellowish with black markings on the wings, and a wing-spread of a little over one inch lays clusters of scale-like eggs on the unopened inflorescence and on the younger leaves of the plant. The eggs are laid when the bunch is being thrown and hatch in six days, when the young larvæ penetrate under the tightly-closed bracts, usually feeding a little on the surface of the bracts. Within a few days the young caterpillars may be found feeding on the basal half-dozen "hands". The surface of the fruit is eaten and as the bunch develops, the larvæ tend to move towards the more sheltered distal "hands" where the bracts open later. Thus the distal hands are more severely damaged than the upper ones, as they are subjected to intensive feeding by the more fully developed larvæ. Much frass and webbing occurs among the distal hands and the larvæ frequently eat into the fruit, leaving only a hollow shell. The scars left on the skin of the fruit are usually alluded to as "scab", and vary from inconspicuous markings on the basal hands to very severe scabbing on the distal ones. As badly scabbed fruit is useless for export, the activities of the pest cause considerable economic loss. The fully developed larva spins a flimsy cocoon within which it pupates, often under the old leaf bases.

*This species appears to correspond with a specimen in the collection of the Fiji Dept. Agric. labelled "*Aspidiotus simmondsi*, Green and Laing."

The standard control measure consists of puffing dust into the "hands" when the bunch has bent over and the outer bracts have opened. The bracts are removed, and dust is puffed into and under the exposed "hands" by using a rubber bulb, containing dust, from which emerges a narrow bamboo pipe. In Fiji, a mixture of pyrethrum flowers and wood ashes is commonly used, and in Samoa a mixture of lead arsenate and sulphur. Recent trials in Fiji indicate that DDT dust gives good control at a low cost. Trials of the various insecticides are to be conducted in Fiji, and spraying of the unopened bunch and surrounding leaflets is also to be tried with a view to killing the young larvæ before they enter the bunch, thus avoiding the necessity of pulling away bracts and treating hands individually.

The Banana Weevil Borer (*Cosmopolites sordidus*, Germ).—Time did not permit of checking on this insect at Vavau but it was found in every banana grove inspected in Tongatabu. Every old, rotted pseudostem examined showed evidence of the presence of the weevil and nothing is done by growers to control the pest.

The adult is black (reddish-brown when it first emerges from the pupal stage) nearly half an inch in length, and with the typical weevil snout. The female lays its eggs in the pseudostem near ground level, first chewing a little hollow in the plant tissue, and placing the egg in the hollow about 1/12th inch below the surface. When the grub hatches from the egg it begins boring in the tissues of the plant, usually not more than a few inches above ground level. The tunnels thus made are very extensive and heavy infestations may cause the death of suckers, greatly reduce the size of bunches, and shorten the useful life of a plantation. When the grub is fully fed it bores its way very near to the surface of the pseudostem, and pupates. The adults move about mainly by night and, though they are able to fly, apparently seldom do so. They shelter in dark situations, under debris and in old, rotted pseudostems.

Control of this pest in mainly a matter of hygienic methods of agriculture[16,17]. The chief measures are as follows: (1) Plant uninfested suckers. To ensure that suckers are free from attack, peel the whole of the corm to a depth of about $\frac{1}{8}$ inch. This will remove any eggs which may be present, and will expose any borings made by grubs. Unless the latter are very shallow, and easy to cut out, the sucker should be destroyed. Removal of roots by peeling will not affect the growth of the sucker. It is best to cut and peel only as many suckers in one day as can be planted on the following day. The suckers should be removed from the plantation before night, otherwise they act as baits for the weevil and many eggs may be laid in them. If paring of the suckers is left until they are transported to the planting site, all parings should be burned or chopped up and laid out in the sun to dry. (2) When the bunch is harvested from a plant the whole pseudostem should immediately be rendered unsuitable for breeding, as old, rotting stems are favoured breeding places. The stem should be split down the middle, chopped into short lengths, and the pieces laid out in the sun to dry. (3) A measure frequently adopted is the use as baits of the bases of plants from which the bunch has been cut. The plant is cut off not more than six inches above the ground, and again at ground level, providing a slice of stem several inches thick. The cut surface of the corm and both surfaces of the slab of stem are then lightly and evenly dusted with a mixture of one part by weight of Paris Green to six parts of flour. Dust should not be applied too heavily as this destroys the attractiveness of the bait. After dusting, the slice of stem is replaced on the butt with a small stick between butt and slab to provide an opening for the weevils to enter. When suckers are cut from a plant the cut surface should be dusted with the mixture.

In Fiji, a predatory beetle, *Plaesius javanus* Er., known as Jepson's Beetle, was introduced from Java over thirty years ago. During the last ten years it appears to have brought about considerable control of the weevil borer. It is proposed to send shipments of this predator to Tonga, where it may ultimately have a beneficial effect.

Other Insects.—No other pests of importance were noted on banana plants. A few specimens of the mealybug *Pseudococcus citri*, Risso, were taken on the leaf of a

young sucker overgrown by yam vines on Tongatabu. The mealybugs were attended by the ant *Pheidole megacephala* Fabr. which had built protective earthworks over them. The aphid *Pentalonia nigronervosa* Caq. was also taken on the central leaves of a plant on Tongatabu, also attended by *P. megacephala*. This aphid is the vector of the disease known as Bunchy Top, but the disease is apparently not a problem in Tonga.

INSECTS OF CITRUS.

Fruit-flies (*Dacus kirki*, Frogg)*and* (*Dacus fascialis*, Coq.).—Citrus fruit throughout Tonga is heavily infested by these species of fruit-flies, *Dacus kirki* being somewhat more numerous than *D. fascialis*. They are handsome flies with conspicuous cream-yellow markings and when at rest hold the wings at an angle of about 45° from the body. *D. kirki* is larger than *D. fascialis*, and has greyish longitudinal stripes on the thorax and a dark longitudinal stripe down the middle of the abdomen.

The flies lay their eggs into ripening fruit and the maggots which hatch from the eggs bore into the fruit and convert the flesh into a slimy mass. The fruit drops to the ground and eventually the maggots emerge and pupate in the soil. Cottrell-Dormer[3] records other fruits from which these flies were bred and records also the occurrence of three other species of fruit-flies, *Dacus xanthodes*, Brown, *Ocneros punctilabris* Bezzi, and *Dacus distinctus* Malloch.

Parasites.—No parasites emerged from several hundred maggots collected in the field, but a single specimen of the Braconid *Phaenocarpa leveri* Nixon, recorded as a parasite of *Drosophilids* in Fiji, was found under a fallen fruit on Tongatabu. The fruit contained numerous fruit-fly and Drosophilid maggots.

Control.—The main measures of control which would be practicable under Tongan conditions are: (1) Fallen fruits should be picked up daily, and those which show evidence of damage by fruit-fly should be destroyed by boiling or by burying under 18 inches of rammed earth. Shallow burying is useless, as the maggots pupate normally and the emerging flies can work their way up through considerable depths of soil. (2) A poisoned bait mixture should be sprayed or splashed with a brush into the foliage in coarse droplets as much as possible under the leaves. This procedure should be carried out each week, beginning when the first fruits begin to show signs of yellowing. The whole of the foliage is not sprayed, the bait being applied in patches on four sides of the tree. About 10 oz. of bait will treat a tree of normal size. Formula for the bait is:—

HETP (Hexaethyl tetra-phosphate)	1 fluid oz.
Sugar	1½ lb.
Water	3 gallons.

The bait should be made up just before use, as it does not keep well.

Coccidæ: Scale Insects and Mealybugs.—Citrus trees in Tonga, as elsewhere, are subject to attack by a variety of species of scale insects and mealybugs which attach themselves to fruit, leaves and twigs, and can cause severe damage by their sucking. Attention is attracted to their presence by the growth of a black fungus—fumagine—on the leaves, which develops on the honeydew secreted by the insects. The following species of Coccids were taken in a citrus orchard near Nuku'alofa:

Icerya purchasi, Mask., the Cottony Cushion scale. (Also taken on citrus at Lifuka.)
Two unidentified species of Coccus.
Lepidosaphes beckii, Newm.
Unaspis citri, Comst.
Chrysomphalus dictyospermi, Morg.

Control.—These pests can be controlled by spraying with white spraying oil, one part in 40 of water.

Mites.—Various species of mites cause scabbing of the surface of citrus fruits. These may be controlled by spraying with lime-sulphur or HETP.

Othreis fullonia, Cl., *the Fruit-Piercing Moth*: is present in Tonga, but evidently causes little damage.

INSECTS OF FRUIT TREES OTHER THAN CITRUS.

Tahitian Chestnut (*Ifi*), *Inocarpus edulis.*—The fruits of this tree are severely attacked by the caterpillar of the moth *Argyrophoce*

illepida, Butler (family Eucosmidæ). The caterpillar feeds on the flesh of the fruit, producing masses of brown frass, and causing premature fall. Pupation occurs in a tough cocoon within the fruit. The pest could no doubt be controlled by regular spraying after setting of the fruit, but the size of the tree makes this impracticable under local conditions. Fallen fruit should be regularly picked up and infested fruits boiled or buried.

Cottrell-Dormer[3] records the breeding of the fruitfly *Dacus fascialis* from ifi fruits.

Avocado Pear: Heliothrips hæmorrhoidalis, Bouche, was observed to be causing silvering of the leaves of avocado trees near Nuku'alofa, but the damage was slight. The scale insect *Hemiberlesia palmæ*, Ckll, was taken in small numbers on the leaves.

Mango.—Small numbers of the scale insect *Hemiberlesia palmæ*, Ckll, were taken on the leaves.

Miscellaneous.—Unidentified scale insects were taken on the leaves of Guava and Indian Jak (*Artocarpus integrifolia*). The fruit-flies *D. kirki* and *D. fascialis* were bred from Guavas, which were severely infested. Pawpaws were not investigated but Cottrell-Dormer[3] records *Dacus xanthodes* as a pest of the fruit.

INSECTS OF ESTATE CROPS.

Neither of the crops mentioned in this section is grown commercially in Tonga but it is considered of interest to record the insects taken on the few odd trees examined.

Cacao.—Mealybugs and aphids were found attacking the pods and their stems, and were fostered by the red ant, *Solenopsis geminata*, Fab.; var. *rufa* Jerd. The mealybugs were *Pseudococcus citri*, Risso, and the aphids were *Aphis gossypii*, Glov. Numerous holes chewed in the leaves were probably the work of the Rose-beetle, *Adoretus versutus*, Har., which is common throughout Tonga.

Coffee.—The following species were taken on the leaves: *Coccus viride*, Green, the flat green scale, *Ischnaspis longirostris*, Sign., the black thread scale, *Pseudococcus citri*, Risso, and the thrips, *Heliothrips hæmorrhoidalis*, Bouche, which was causing silvering of the leaves.

INSECTS OF NATIVE GARDEN CROPS.

Sweet Potato: Euscepes postfasciatus, Frm, is a dark brown weevil, about 1/7th inch long, with a conspicuous transverse white mark across the posterior portion of the elytra, or wing-covers. Under a magnifying-glass the weevil is seen to be liberally clothed with scales of various colours. The white, curled grubs of this weevil bore in the runners and tubers of sweet-potato plants and pupate in the feeding-channel when fully fed.

Methods of control consist of hygienic agricultural practices, and are as follows:—

(1) Make sure that planting material is not infested.

(2) Plant deep, and keep the developing tubers well covered with soil.

(3) Where possible, avoid planting successive crops of sweet-potato in the same plot. A crop should be planted as far as possible from the preceding one.

(4) When harvesting, try to avoid leaving any tubers in the soil and burn the tops as soon as they are sufficiently dry. All weevil-infested tubers should be destroyed.

Slugs.—These attack the leaves of sweet-potato plants, and especially damage young plants. They may be controlled by the use of metaldehyde baits, made by thoroughly mixing half an ounce of powdered metaldehyde with one pound of bran or sawdust and adding sufficient water to make a crumbling mash. Small heaps of the mixture, containing about a teaspoonful, are placed on the ground and around and in the crop, or the mixture may be broadcast. Alternatively, the crop may be sprayed with calcium arsenate or lead arsenate.

Dalo (*Colocasia esculenta*).—This crop appeared to be singularly free from pests. The leafhopper, *Tarophagus proserpina*, Kirk, has been recorded from Tonga but was not seen. The Derbid, *Pyrrhoneura sacchaaricida*, Kirk., was frequently found nesting under dalo leaves but is of no economic importance. Severe infestations of the taro leafhopper may be well controlled by spraying or dusting with DDT.

Yam (*Dioscorea* spp.).—No important pests were noted. A leaf-miner commonly bores in the leaf-petioles, and at the base of

leaves, but does only slight damage. Slugs eat the foliage and could be controlled by metaldehyde baits or poison sprays. The mealybug *Pseudococcus citri*, Risso, was taken on inflorescences, and the scale insects *Pinnaspis strachani*, Cooley, *Hemiberlesia cyanophylli* Sign., and *H. lataniæ*, Sign., from runners, but in insignificant numbers.

Tapioca.—This crop is very free from pests. The scale insect *Saissetia nigra*, Nietn. occurred in considerable numbers on stems of plants near Nuku'alofa, and was heavily parasitized by the Pteromalid wasp, *Tomocera californica*.

Maize.—The Delphacid, *Peregrinus maidis*, Ashm., and the Aphid, *Rhopalosiphum maidis*, Fitch., occur commonly on maize, without doing any considerable damage. A beetle, *Aulacophora* sp., feeds on the leaves, and the leaf-tissue is also eaten by Noctuid caterpillars. There are no serious pests.

Bele (*Hibiscus manihot*).—This crop is severely attacked by the larvæ of an unidentified moth, which bores in the shoots. Spraying or dusting is not practicable, as the foliage is used for food. The only practicable method of control seems to be picking off and crushing the shoots which are attacked.

Pineapple.—This crop is attacked by the mealybug *Pseudococcus brevipes*, Ckll., which is usually found at the bases of the leaves and is attended by the red stinging ant, *Solenopsis geminata*, Fab., var. *rufa*, Jerd. Damage is not severe, and the fruits appear to be free from attack. Experience with this mealybug in Hawaii, where it is a serious pest, indicates that control of ants is necessary for suppression of the pest.

Tobacco.—Boring larvæ, presumably those of the moth *Gnorimoschema heliopa*, Low., bore in the leaf midribs and in the stems of tobacco plants, causing swellings in the latter. Control is largely a matter of hygienic practices. (1) When the crop has been harvested, all remaining plant material, including volunteer plants, should be destroyed. (2) On the growing crop all swollen shoots should be removed and destroyed. If the growing point is attacked, cut back to a sucker in the axil of a lower leaf. (3) Hilling up the soil around damaged stems helps the formation of new roots. (4) Control by artificial means may be obtained by dusting the plants every ten days with DDT, from the seedling stage until a month after planting out.

Other pests of minor importance are an unidentified mealybug, and a small Capsid bug (*Engytatus tenuis*, Reut., or a closely-related species).

Sugar-cane.—The weevil borer, *Rhabdoscelus obscurus*, Boisd., occurs on this crop, which is not grown on a commercial scale. The adults may be found between the leaves and the stem, and the larvæ bore in the stem, destroying the tissue and setting up rots.

Control.—(1) Plant uninfested material. (2) Do not grow ratoon crops. (3) Destroy residue of harvested crop by burning. (4) Avoid wet, undrained ground. (5) Collect and destroy adult beetles.

Cottrell-Dormer[3] has recorded the occurrence of the leafhopper, *Perkinsiella vitiensis*, Kirk, on cane.

INSECTS OF EUROPEAN VEGETABLES.

Cabbage and Cauliflower.—The large cabbage moth, *Crocidolomia binotalis*, Zell., attacks cabbages and cauliflowers, the caterpillars feeding on the larger leaves and on the centre. These caterpillars are green, with median and lateral white stripes and three black dots on the side of each segment. Pupation occurs in the soil. The smaller cabbage moth, *Plutella maculipennis*, Curt., has also been recorded from Tonga, and in 1943 a consignment of the parasite *Diadromus collaris*, Grav., was sent to Tonga from Fiji for control of this insect. Control of caterpillars attacking cabbage may be obtained by spraying or dusting with DDT, treatments beginning soon after planting out and being repeated fortnightly until one month before the vegetables are to be consumed.

Tomato.—This crop was attacked by the following pests, none of which was causing serious damage: the 28-spotted ladybird beetle, *Epilachna 28-punctata*, the Capsid bug, *Engytatus tenuis* Reut. (or a closely related species), the Green Vegetable Bug,

Nezara viridula, Linn., and caterpillars of the Noctuid moth, *Plusia chalcytes*, Esp. All of these pests could be controlled, if necessary, by spraying or dusting with DDT. Some years ago, the bug *Nezara viridula* was a serious pest around Nuku'alofa but appears to have been controlled by the introduction from Fiji of the egg-parasite *Microphanurus basalis*, Woll.

Beans.—Young plants are attacked by the red, stinging ant, *Solenopsis geminata*, Fab. var. *rufa* Jerd., which eats the stems both above and below the ground level, and causes the death of the plants. It may be controlled by spraying the soil where the ants nest with Chlordane emulsion. The ladybird beetle, *Epilachna 28-punctata*, feeds on the foliage, where it could be destroyed by spraying or dusting with DDT or arsenicals. The caterpillar of a Pyralid moth bores in the pods and could probably be controlled by fortnightly sprayings with DDT from the time of setting of the fruit.

Pumpkins and Cucumbers.—The leaves are devoured by a yellow beetle of the genus Aulacophora, which may be controlled by spraying or dusting with DDT or arsenicals.

INSECTS OF ORNAMENTAL PLANTS.

Frangipani.—Various species of scale insects attack this plant, including the flat, green scale, *Coccus viridis*, Green, *Saissetia nigra*, Nietn., *Hemiberlesia palmæ*, Ckll., *Chrysomphalus dictyospermi*, Morg., and *Ischnaspis longirostris*, Sign. Two species of ladybird beetles were found preying on the scale insects, namely *Cryptolæmus montrouzieri*, Muls., and a very large unidentified species. Where natural control proves insufficient to suppress the scale insects they may be controlled by spraying with white spraying oil.

Hibiscus.—*Aphis gossypii*, Glov., and the scale insects *Saissetia nigra*, Nietn., were taken on this plant, the latter being heavily parasitized by Chalcidoid wasps.

Cannas and Roses.—The leaves of these plants were freely chewed by the beetle *Adoretus versutus*, Har., which also attacked the petals of the roses. The activities of this beetle may be checked by spraying with DDT as required.

Lawns and Tennis Courts.—The ant *Solenopsis geminata*, var. *rufa* Jerd., is a pest of tennis lawns, as it nests in the soil and throws up quantities of soil, thus affecting the bounce of the ball. It was found that the nests could be eliminated by watering the soil with chlordane 74 per cent emulsion, one part to 1,000 of water (1 fluid ounce to 6 gallons).

MISCELLANEOUS.

Blow-flies.—Trapping carried out with a trap baited with decayed meat showed that the three common blow-flies of Fiji, *Chrysomyia megacephala*, Fabr., *C. rufifacies*, Macq., and *Microcalliphora varipes*, Macq., also occurred commonly in Tonga. The Ortalid, *Scholastes bimaculatus*, Hendel, was also taken in the traps.

Ants.—Most of the ants encountered were species widely distributed in the southern Pacific area, including *Tapinoma melanocephalum*, Fabr., *Anoplolepis longipes*, Jerd., *Pheidole megacephala*, Fabr., and *Technomyrmex albipes*, Smith. The red stinging ant, *Solenopsis geminata*, Fab., var. *rufa* Jerd., was commonly met with in houses and in the field. It is of interest that *P. megacephala* does not occupy the position of dominance in Tonga which it has achieved in some other islands of the Pacific. It was found in scattered localities in Tongatabu, and is possibly a recent immigrant. Its future development in Tonga is worthy of special observation.

Beneficial Insects.—Scale insects, mealybugs and aphids seem to be under very good natural control in Tonga. The only really heavy infestation seen was of the scale insects *Lepidosaphes beckii*, Newm. and *Unaspis citri*, Comst. on citrus trees. The larvæ of a Cecidomyiid fly, similar to, or the same as a species occurring in Fiji, were found attacking mealybugs on coconuts and *Pseudococcus citri* on a variety of host plants, including cacao, banana, yam and *Mimosa pudica*. Various species of Chalcidoid wasps attacked *Saissetia nigra*, Nietn., on Hibiscus and Tapioca. The moth *Agonoxena argaula*, which attacks the leaves of the coconut

palm, is heavily parasitized by a species of *Brachymeria*, probably *B. fijiensis*. Aphids on cacao and scale insects on frangipani are preyed on by a large, unidentified Coccinellid. Identifications of the parasitic and predatory species will be supplied as soon as they are available. Among bene ficial Coccinellids taken were *Cryptolæmus montrouzieri*, Muls., attacking *Coccus viridis*, Green, on Frangipani; *Coelophora inæqualis*, F., on Hibiscus; and *Coccinella transversalis*, F., sweeping in plantations. The bug *Teleonemia scrupulosa*, Stal., which was introduced from Fiji to control Lantana, can be found on Tonga tabu, but has no evident controlling effect on its host.

General Notes on Control of Insect Pests.

The three main methods of insect control may be stated as cultural, artificial and biological. As biological control, i.e. the introduction and establishment of beneficial species, is a task for trained entomologists, it will not be discussed here.

Cultural Methods.—These consist of commonsense methods of agricultural practice designed to prevent or reduce loss by insect attack, and are largely neglected in Tonga. They have been dealt with in connexion with specific pests, for instance banana weevil, sweet potato weevil and fruit flies. Two of the most important measures are crop rotations and the cleaning up of crop residues. One practice which seems common in Tonga, and which cannot be too strongly condemned, is the burning of plantation refuse at the base of coconut palms. The trunks of the palms are scorched, causing death of surface tissue and providing entry for fungi such as the stem-bleeding fungus, *Thielaviopsis paradoxa*. If rubbish must be burnt, which seems unnecessary, the burning should be done well away from the bases of palms.

Artificial Control.—This includes the use of insecticides, and it is thought worth while to provide some notes on this subject. During recent years, the older insecticides have been to a great extent displaced by the modern organic compounds such as DDT, Gammexane, and Chlordane. The uses of some forms of these insecticides are outlined below:

DDT. Water-dispersible Powder, Containing 50 per cent p-p'isomer of DDT.—This form of DDT is a very useful general-purpose formulation. It is made up into an agricultural spray by mixing one pound of the powder with 50 gallons of water. This spray is very useful in the control of both chewing and sucking insects which attack crops, though it is not effective against many scale insects, aphids and mealybugs. When used on leafy vegetables, such as cabbage and cauliflower, it should not be applied within a month of the time when the vegetables are to be consumed. DDT sprays have been used to control fruit-fly attacking citrus and other fruit trees but have frequently to be supplemented by other sprays to control red-spider, scales, aphids and mealybugs, which may increase in numbers due to killing of their parasites and predators.

For residual spraying of houses, stables, etc., to control mosquitoes and flies, the water-dispersible powder is mixed with water at the rate of one pound to one gallon. This leaves a deposit of DDT which is lethal to flies and mosquitoes for several months.

DDT Agricultural Dust, Containing 2 per cent p-p'isomer of DDT.—This dust is used undiluted for the control of crop pests when dusting is preferred to spraying. Dusting can be carried out much more rapidly than spraying, but a dust does not adhere to the leaf surface as well as a spray. Dusting should be carried out preferably in the early morning, when there is little wind and dew is on the plants.

Gammexane Agricultural Dust.—Useful in the control of various crop pests but imparts an undesirable flavour to some of the plants treated.

Hexæthyl tetraphosphate (HETP) and Tetræthyl pyrophosphate (TEPP).—These compounds have largely replaced Nicotine sulphate and are used in the control of mites, thrips and aphids, as well as in fruit-fly foliage baits. They are used at very high

dilutions of 1/1600 upwards and must be mixed just before spraying, as they break down rapidly in water. These compounds are very poisonous, and should be handled with care.

Derris Sprays and Dusts.—Useful for application against crop pests when a non-poisonous spray or dust is called for, as they leave no lethal deposit.

White Spraying Oil.—Used for control of scale insects, aphids and mealybugs, at a dilution in water of 1/40.

Metaldehyde.—The best substance for making up baits for snails and slugs. The pests are attracted to the bait and killed. Half an ounce of powdered metaldehyde is mixed with one pound of bran or sawdust, and water is added to produce a crumbling mash. This is broadcast in the evening or placed in small heaps of about half a teaspoon round beds to be protected. Metaldehyde is inflammable and toxic to humans.

Paris Green.—This highly poisonous arsenical is used in the preparation of baits for cutworms and armyworms. One pound of the powder is thoroughly mixed with 25lb of bran or sawdust and half a gallon of molasses and sufficient water to make a crumbling mash is added. Broadcast in the evening. Recent experiments in Fiji indicate that water-dispersible DDT (50 per cent p-p'isomer) may be used instead of Paris Green, making handling of the bait much safer. Half a pound of the powder is used instead of one pound of Paris Green.

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FISHERIES

FISH CULTURE IN PONDS

BY H. T. B. HALL, B.V.Sc.

In July, 1947, Dr. C. F. Hickling surveyed the fisheries resources of this Colony and as part of his report he made recommendation for the establishment of fish ponds for the production of fish by hand rearing.

He suggested that the ponds might be constructed in either the freshwater streams or along the sea shore, within the mangrove belt. In both cases it was recommended that *Chanos chanos*, the common "yawa" or "luya" should be used, and details of the method of stocking the ponds and growing the fish were left with the Department of Agriculture.

An experimental pond was established in April, 1948. Earlier experiments with fresh water ponds at Naduruloulou had shown that the difficulties of maintaining a suitable dam across a creek were considerable, mainly owing to the thickness of mud under water and the consequent difficulty of establishing the retaining wall on a solid foundation. Moreover, it was clear that any heavy downpour upstream from the dam would flood the pond and wash out the young fish. Nevertheless it was considered that where a stream could be found which passed through a wide upland flat a freshwater pond could be established. In such circumstances the pond can be excavated to one side of the main body of water, and be provided with an inlet and outlet so that the level of water could be controlled. A number of places of this description were found but as they were all so distant from Suva the expense involved in properly supervising them would have been too great.

In the case of salt water ponds it was found that the cost of building suitable embankments to enclose the pond would have been much more than available funds would permit. Ponds of this type will only be successful on a large scale with an expenditure of many hundred of pounds.

It was finally decided to build the experimental pond within the Animal Quarantine Station at Vatuwaqa where, by excavation into the soapstone, a satisfactory pond was established. It is some eighty feet from the sea close to the mouth of the Vatuwaqa River. The water level in the pond can be controlled through a channel leading to the river. The rise and fall of tide at Vatuwaqa is sufficient to cause a flow in either direction from the pond according to the state of tide.

The pond was stocked with 70 "Yawa" fingerlings in May, 1948, the fingerlings having been obtained from the inlets on the sea coast at Nadi. Transport of the fingerlings to Suva resulted in the death of some 25 and the remainder were placed in the pool on May 22nd.

The average length of the fingerlings was three inches. It would have been preferable to have obtained fry of one inch in length but there appears to be a regular breeding season with "Yawa" so that fry can only be obtained in March.

A standard feeding practice was established which included a handful of coconut meal daily and chaffed grain and rice bran every few days.

A dressing of lime and superphosphate was given to the water twice during the time that the experiment was conducted.

Owing to periodical flooding from rainfall, the water did not remain at the full salinity of sea water throughout the experiment; salinity tests at various times gave concentrations varying from full salinity down to 495·8 parts per 100,000 which is approximately one-seventh sea water.

The pH was taken twice during the experiment with the following results:—

24th May, 1948	7·07
16th July, 1948	7·85

It is possible that 7·85 is a little too alkaline, although the pH should be on the alkaline side of neutrality.

Good growth of algæ occurred in the early stages but it was observed that although occasional dressings of animal manure were made, the algæ disappeared from time to time. The water remained cloudy or opaque except after heavy rain, but the greenish tinge which is ideal for fish culture seemed to fluctuate in intensity. As the greenish tinge is due to the growth of algæ, it is feared that occasionally this growth was insufficient to meet the requirements of the fish. Variation in salinity appears to interfere with the normal growth of algæ.

The fish were observed from time to time and appeared to be growing well. On 21st February, 1948, the pond was drained and the fish collected. Only 28 remained, and of these the heaviest weighed just over one pound, which would, according to Dr. Hickling, be a good weight for *Chanos* to attain in six months, not nine, while fresh-water fish intensively fed will reach three to four pounds in nine months. It therefore remains for us to investigate the cause of this lack of development.

Firstly, it appears that lack of proper development of algæ must have caused periods of starvation. This was insufficient to cause death but was sufficient seriously to slow down the rate of growth. It is difficult to suggest ways of overcoming this. If a salt water pond is to be used the high rainfall of the Suva area must always cause fluctuations in salinity but it may be considerably lessened if the channel leading to the sea is opened every few days or at least after every heavy downfall. The fact that such a state of affairs will always be present indicates that a fresh water pond operated by the side of a running creek would be the better proposition.

A probable second cause of under-development in the fish was the temporary fluctuations in the depth of the water. Although the depth was never below two feet it sometimes came to as high as three feet six inches and although no obvious interference with fish growth is attributable to this cause it probably had the effect of killing off certain algal growths which are sensitive to fluctuations in water level.*

* Frey, D. G. The Pond Fishes of the Philippines. *Journal of Marine Research*, VI, 3, p. 247.

Finally the local feeding habits of *Chanos chanos* under conditions of partial salinity are scarcely well enough known for the feeding routine to have become established on the right basis. It is well to mention that, in addition to the earlier feeding of the coconut meal and rice bran, a good growth of soft grasses was allowed to develop at the edges of the pool and from time to time soft leaved plants were thrown in as food. On no occasion were these observed to be eaten by the fish. The need for such food is pointed out by Dr. Hickling in various communications and it remains for us to find the right plant to suit the taste of the fish.

One interesting point which should be borne in mind for future experiment is that by accident one "Vuvula" (*Megalops cyprinoides*) was inadvertently included with the fingerlings brought from Nadi. This appears to be a predacious fish but as it was the same size as the "Yawa" it caused no damage to the latter. It grew at a slightly faster rate than the "Yawa" and when taken from the pond at the termination of the trial it proved to be equal in size to the biggest "Yawa".

This fish ("Vuvula") is, in fact, more acceptable to the Fijian taste as a food fish and one of the most important investigations for the future will be a comparison of the growth rate between the two above named fish. To this end the pond has already been re-stocked with an approximately equal number of "Yawa" and "Vuvula" and, provided that some system can be devised to control the salinity, a direct comparison of the relative growth rates of the two fish can be made. This will form the subject of a further report in due course.

A point to be noted in regard to culture of "Vuvula" is that it may spawn in captivity, which "Yawa" has not been known to do. In this way the pond may be kept stocked without difficulty.

In conclusion it must be borne in mind that on the scale of the experiment as carried out the economics of production could not be satisfactorily investigated. The pond was too small to be economically feasible. It measured only 40 ft. x 40 ft. The "Tambaks" of China and Java are usually

two hundred yards square and they are usually stocked to a much heavier capacity. When future experimental work has shown that " Yawa " or some other fish can be grown on the lines suggested by Dr. Hickling it would be worth while for larger ponds to be established. Overseas experiments indicate clearly that fish farming produces more food per acre than any other type of animal production and with the general lack in Fiji of animal protein the possibilities of fish farming on these lines are obvious.

PERSONAL NOTES

Mr. B. E. V. Parham's work in the Department of Agriculture received recognition in the Birthday Honours when he was awarded an O.B.E. Since joining the Department in 1933 Mr. Parham has carried out much valuable research work and the results of his botanical work are widely known outside Fiji. Among the Fijians he has given much attention to practical agriculture, especially in the organization of food production for the army during the war years.

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PLANS TO RAISE AGRICULTURE IN THE COLONIES

Extract from Fiji Times and Herald, 24th June, 1949.

Important recommendations for improving standards of agriculture in the Colonies are made in a report issued yesterday by the Colonial Office, states an official release.

Entitled "Agricultural Extension and Advisory Work with Special Reference to the Colonies", the report, is written by C. W. Lynn, who in 1947 made a tour of agricultural extension work in East and West Africa, Britain, Canada, the United States, and Puerto Rico.

"Agricultural extension" is the term used to describe the complex process by which rural peoples are persuaded to adopt improved farming methods and ways of living.

Research in the Colonies is being intensified and extension work is to make known the results of this research and to see that its principles are put into practice. Otherwise it is possible that many central research stations in dependent territories will become an "Ivory Tower", divorced from the farmers.

HIGHER PRODUCTION.

Sir Frank Stockdale, deputy chairman of the Colonial Development Corporation, estimates in a foreword to the report that if the knowledge which was accumulated in the last 20 years were applied in the Colonies it would raise production at least 25 per cent.

Mr. Lynn suggests that in Africa the distribution of the extension staff should follow tribal organization.

He warns that methods pursued in Canada and the United States are not always applicable, due to limited transport and other reasons, but he strongly advocates demonstration plots and farms as particularly applicable to the Colonies.

The radio is suggested as an important means of educating urban opinion.

FILMS PREPARED.

The Colonial Film Unit, he reports, is preparing basic films on rural problems in East and West Africa.

He believes there is scope for the development of rural youth clubs in the Colonies and of plans for small farmers to purchase ploughs,cultivators, and other items through loan schemes.

The flexibility and individuality of the Young Farmers' Club movement in Britain, he says, show the qualities which should guide early attempts to introduce youth clubs into Colonial territories.

IMPORTANT POINTS.

Mr. Lynn makes these points: Extension must be supported by continuous research; voluntary local leadership is all-important in extension work; agricultural programmes must take into account the social circumstances of the people and the social implications of agricultural policy; junior staffs in colonial departments are the key extension workers.

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A NEW TRACTOR

Details have now been given of the new tractor being made by the Nuffield Organization. This tractor, known as the Nuffield Universal tractor, is a medium-powered, wheeled, paraffin-driven model selling at £495 for the standard 4-wheel model and £487 10s. 0d. for the rowcrop model. The power unit is a 4-cylinder side valve heavy-duty engine. Starting from cold is on petrol with a manually adjusted hot-spot and twin carburettors to eliminate the need for draining when changing from petrol to oil. An electric starter is a standard fitting. Turning-circle is the tractor's own length. Radiator chaff-screens are standard fitting; instruments are clearly visible and every control is readily accessible from a driver's seat. The Farmer and Stockbreeder reports that on a short field trial the Nuffield was seen with a Ford-Ransome 10-inch four furrow plough on heavy load with some incline. Even with this load reserve of power was considerable. The horse-power rating is 35 at 1,400 revs. per minute and 42 at 2,000 revs. per minute. With the necessary additional equipment the change from four to three wheels can be made in half an hour. The range of wheel adjustments for the front axle are from 44″ to 76″ on track widths and for the rear from 52″ to 88″. For the present this tractor is being manufactured for home requirements, but it would be well worth while for officers home on leave to make a point of seeing it at work as it is possible that some machines will be available for overseas.

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POTENT NEW CHEMICAL KILLS ATHLETE'S FOOT FUNGUS

Development of a potent new chemical which kills the fungi responsible for athlete's foot, ringworm of the scalp and plant losses estimated at more than two billion dollars a year was announced before the American Chemical Society.

The synthetic product, called Echridine, is so powerful that in laboratory tests it has proved effective against fungi even when diluted to a strength of one part in 150,000 according to Dr. F. E. Cislak, Director of Research of the Reilly Tar and Chemical Corporation, Indianapolis, Indians.

He emphasized that proof of Echridine's therapeutic value must await the outcome of extensive clinical tests. Besides its effectiveness in laboratory tests against athlete's foot, Echridine has proved fatal to fungi causing lumber decay, mildew staining of fabrics, molding of leather and rotting of tents, ropes and tarpaulins.

It is known technically as 4-(4-ethylcyclohexylmethyl) pyridine. Previous attempts to prepare fungicides from pyridine had resulted in failure because of the widespread assumption that pyridine, a product of coke oven gases of steel mills, had only mild fungicidal properties.

"Chemistry and Chemical Engineering in the U. S. A. —November, 1948".

PRODUCE (IMPORTS AND EXPORTS) FOR 3 MONTHS ENDING 31ST MARCH, 1949.

	Quantity	New Zealand		Australian		Other Countries		Total Value	
		Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
IMPORTS.	lb	£F	£F	£F	£F	£F	£F	£F	£F
Fresh fruits—									
New Zealand ..	76,786	1,796	....	....	....	..	....	1,796	....
Australia	25,132	....	....	895	....	....	....	895	....
U.S. of America ..	1,120	....	....	....	....	6	....	6	....
Vegetables—									
New Zealand ..	281,299	6,579	....	....	....	....	....	6,579	....
Australia	100,800	....	....	1,262	....	....	....	1,262	....
U.S. of America ..	291	....	....	....	....	12	....	12	....
Garlic—									
New Zealand ..	34,548	1,512	....	....	....	....	....	1,512	....
Australia	17,158	....	....	736	....	....	....	736	....
India	137	....	....	....	....	26	....	26	....
China.	1,657	....	....	....	....	91	....	91	....
Onions—									
New Zealand ..	456,727	6,865	....	....	....	....	....	6,865	....
Australia	11,475	....	....	252	....	....	....	252	....
Potatoes—									
New Zealand ..	1,118,857	11,999	....	....	....	....	....	11,999	....
Australia	27,664	....	....	367	....	....	....	367	....
Other vegetables									
New Zealand ..	36,153	851	....	....	....	....	....	851	....
Australia	2,173	....	....	76	....	....	....	76	....
Spices—									
New Zealand ..	485	84	....	....	....	....	....	84	....
Australia	11,285	....	....	705	....	....	....	705	....
India	10,646	....	....	....	....	2,892	....	2,892	....
Malaya	198	....	....	....	....	76	....	76	....
Ceylon	18	....	....	....	....	2	....	2	....

PRODUCE (IMPORTS AND EXPORTS) FOR 3 MONTHS ENDING 31ST MARCH, 1949.

	Quantity	New Zealand		Australian		Other Countries		Total Value	
		Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports
EXPORTS.	lb	£F	£F	£F	£F	£F	£F	£F	£F
Bananas—									
New Zealand ..	3,179,610	....	24,566	....	....	....	....	....	24,566
Canada	63,750	....	....	....	....	....	839	....	839
Mixed fruit—									
New Zealand ..	3,040	....	63	....	....	....	....	....	63
Pineapples—									
New Zealand ..	60	....	1	....	....	....	....	....	1
Peanuts (in shell)—									
New Zealand ..	158,800	....	5,559	....	....	....	....	....	5,559
Australia	6,600	....	....	....	220	....	....	....	220
Samoa	2,500	....	....	....	....	....	83	....	83
Green ginger—									
New Zealand ..	34,050	....	570	....	....	....	....	....	570
Australia	25,650	....	....	....	428	....	....	....	428
Canada	150	....	....	....	....	....	3	....	3
Avocado pears—									
New Zealand ..	330	....	8	....	....	....	....	....	8
Arrowroot—									
New Zealand ..	2,600	....	98	....	....	....	....	....	98
Dalo (taro)—									
New Zealand ..	2,480	....	14	....	....	....	....	....	14
Canada	112	....	....	....	....	....	1	....	1
Peanuts (shelled)—									
New Zealand ..	117,000	....	5,850	....	....	....	....	....	5,850
Coconut meal—									
New Zealand ..	86,280	....	553	....	....	....	....	....	553
Mixed vegetables—									
New Zealand ..	480	....	5	....	....	....	....	....	5
Oranges—									
New Zealand ..	60	....	1	....	....	....	....	....	1
Canada	60	....	....	....	....	....	1	....	1
Grape fruit—									
New Zealand ..	120	....	2	....	....	....	....	....	2
Canada	60	....	....	....	....	....	1	....	1
Rice bran—									
New Zealand ..	116,500	....	650	....	....	....	....	....	650
Yams—									
New Zealand ..	480	....	3	....	....	....	....	....	3
Pawpaw—									
New Zealand ..	800	....	2	....	....	....	....	....	2
	....	£29,686	£37,945	£4,293	£648	£3,105	£928	£37,084	£39,521

The following commodities are not included: Flour, Sharps, Rice, Sugar, Copra and Coconut Oil.

R. A. KABLE,
Produce Inspector.